# Maritime Disaster Preparedness

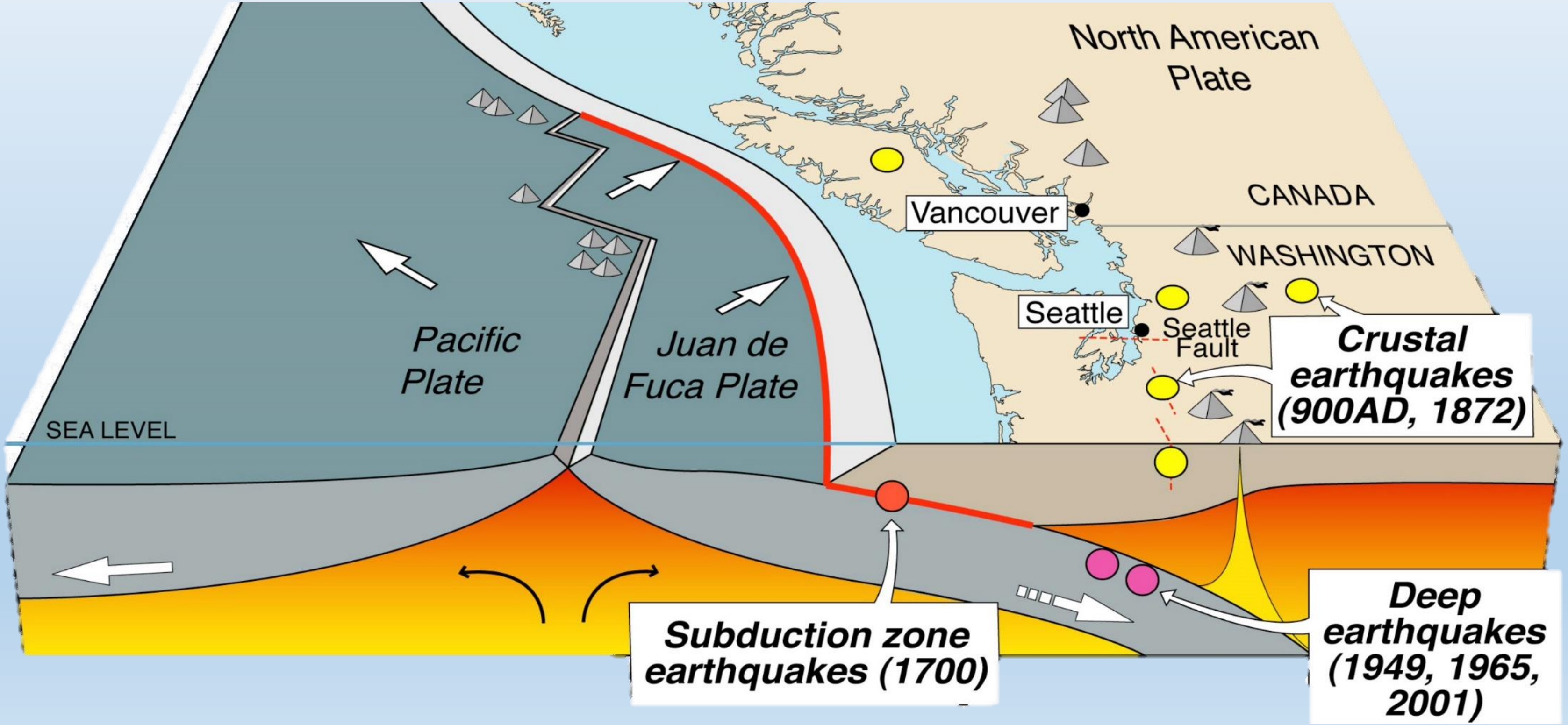
Maximilian Dixon

Hazards and Outreach Program Supervisor

Tohoku 2011

# Washington's Tsunami Risk

Washington has the 2nd highest earthquake risk in the nation



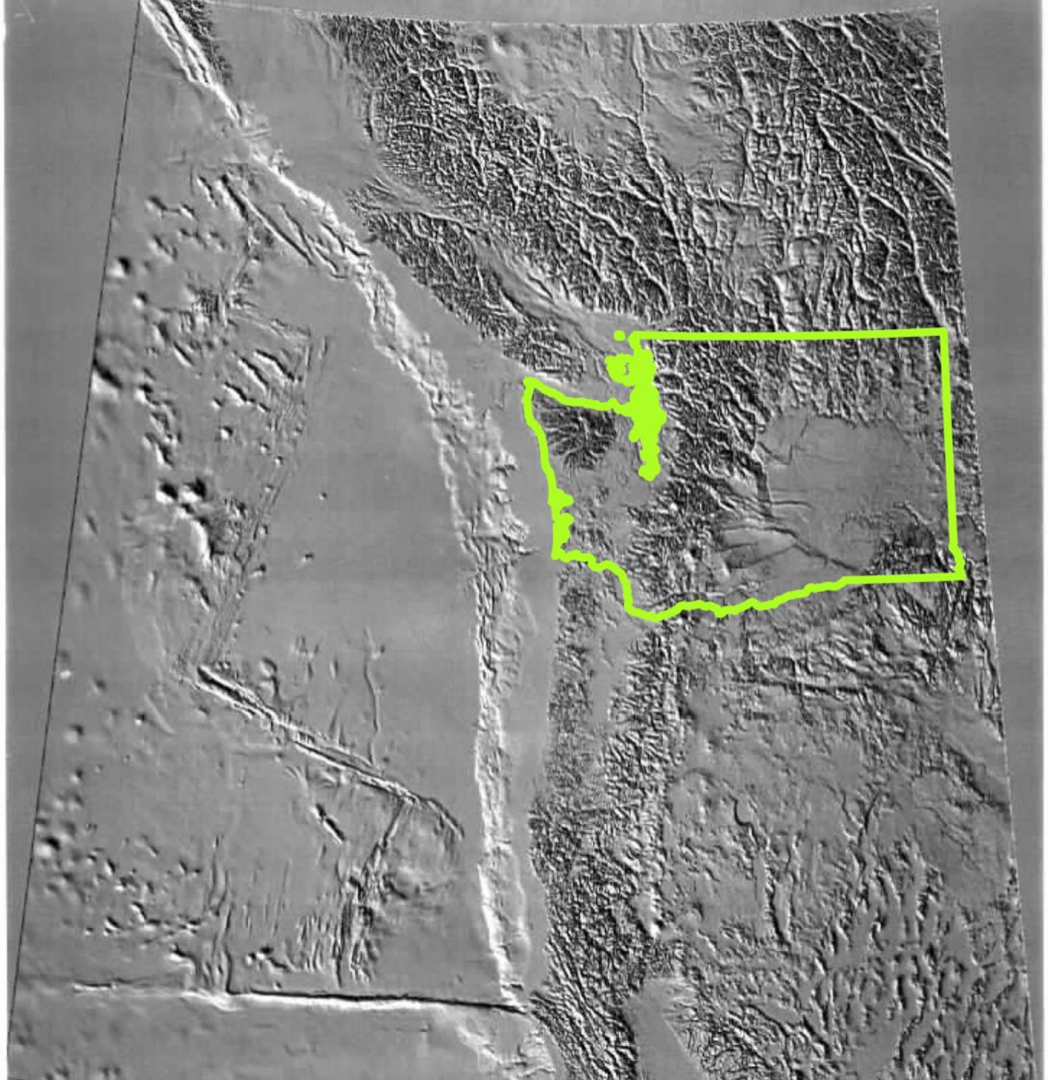
**Crustal earthquakes (900AD, 1872)**

**Subduction zone earthquakes (1700)**

**Deep earthquakes (1949, 1965, 2001)**

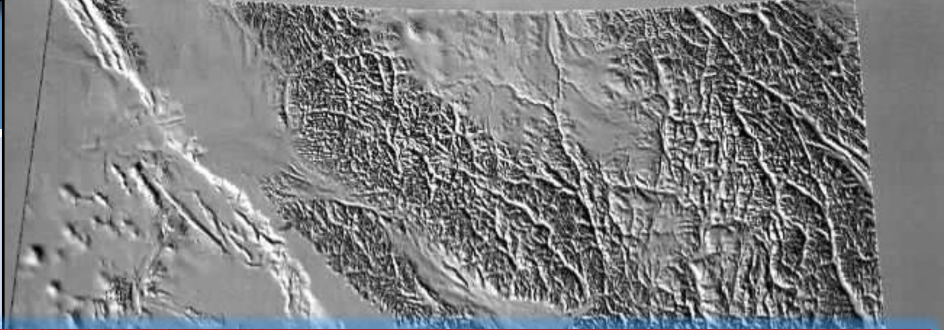
# Cascadia Subduction Zone

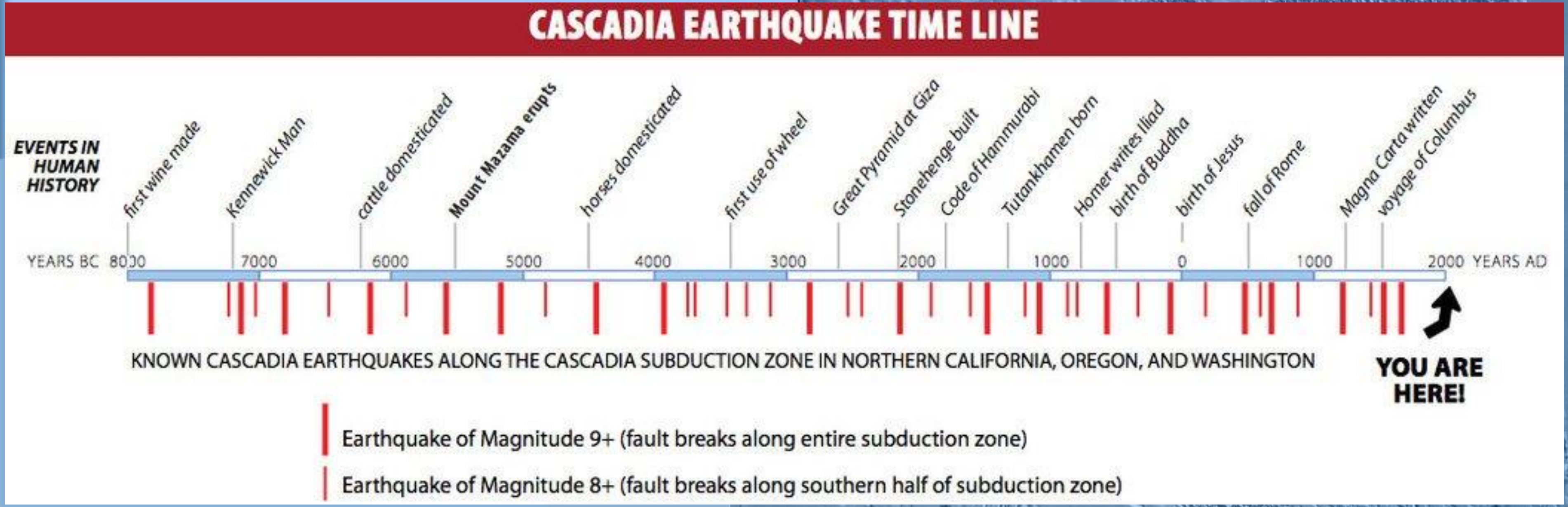
700 miles long



# *Cascadia Earthquakes*

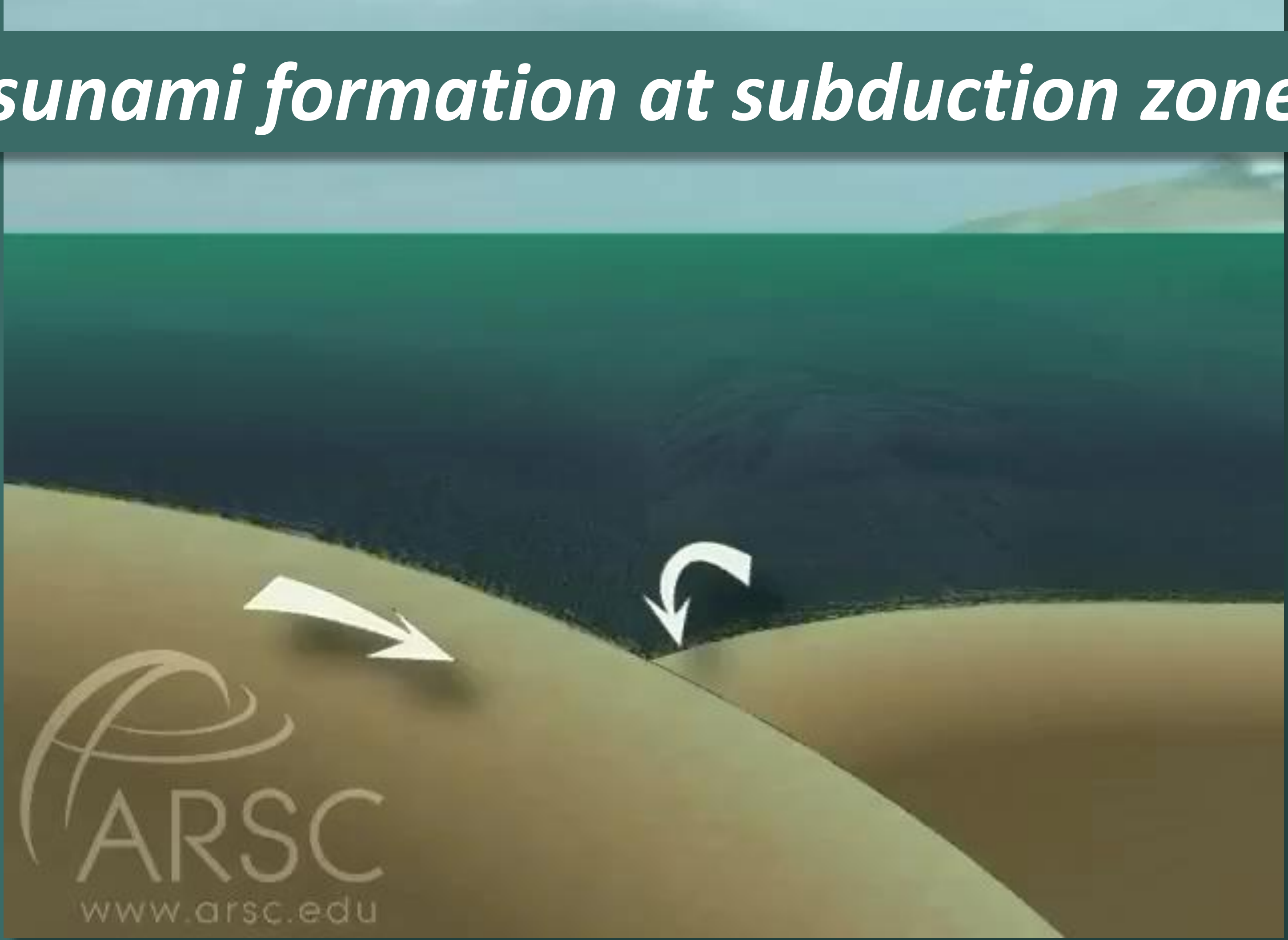
## 23 in the last 10,000 years from turbidite evidence





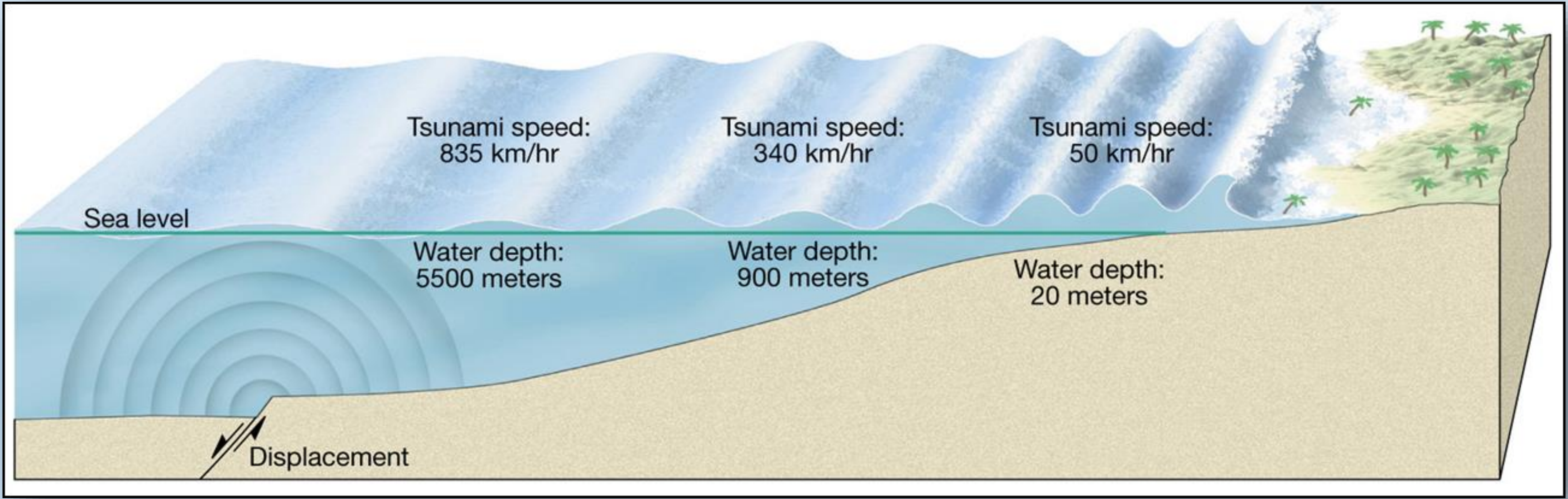
Goldfinger et al., 2012, 2017

# *Tsunami formation at subduction zones*



# Tsunamis are…

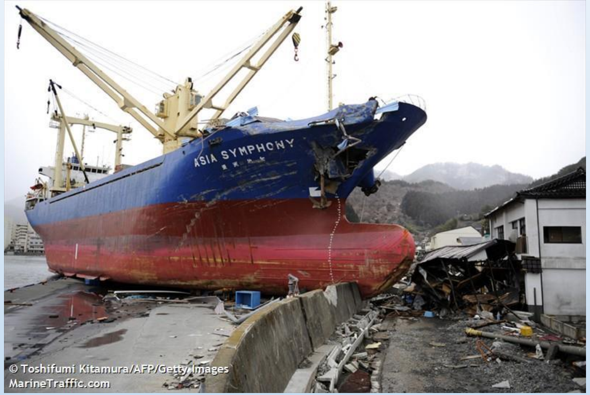
- Fast
- Powerful
- Multiple waves
- Unexpected



# Distant vs Local Tsunamis

| Distant | Local |
|---|---|
| • No earthquake felt | • Event will typically be felt |
| • >3 hours until first wave arrives | • < 3 hours until first wave arrives |
| • Warning must be distributed | • Earthquake is primary warning |
| • Less inundation/currents | • More inundation/currents |
| • Less severe impact to coast | • Significant impact to coast |

# **Impact**: Maritime Loss Example



© Toshifumi Kitamura/AFP/Getty Images
MarineTraffic.com

## Tohoku, 2011

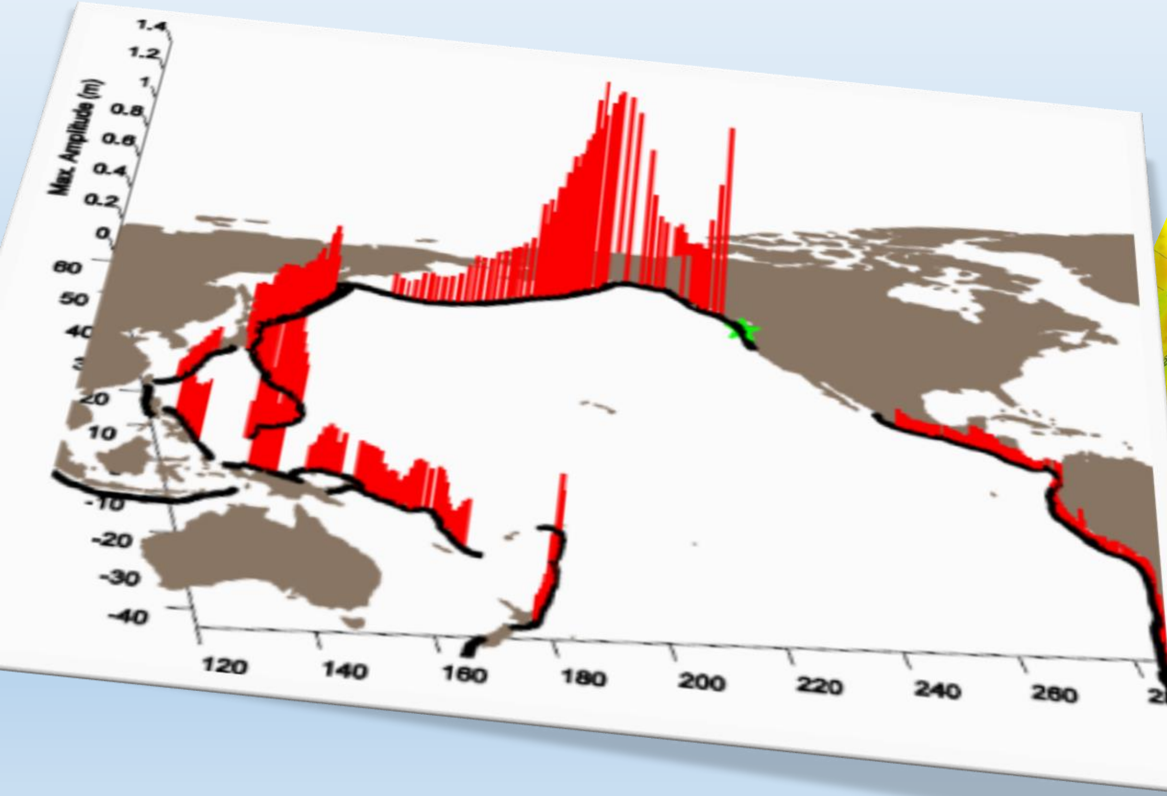
- 28,000 ships destroyed
  - 26 large freighters
- 319 ports destroyed
- Economic loss of $3.9 Billion/day

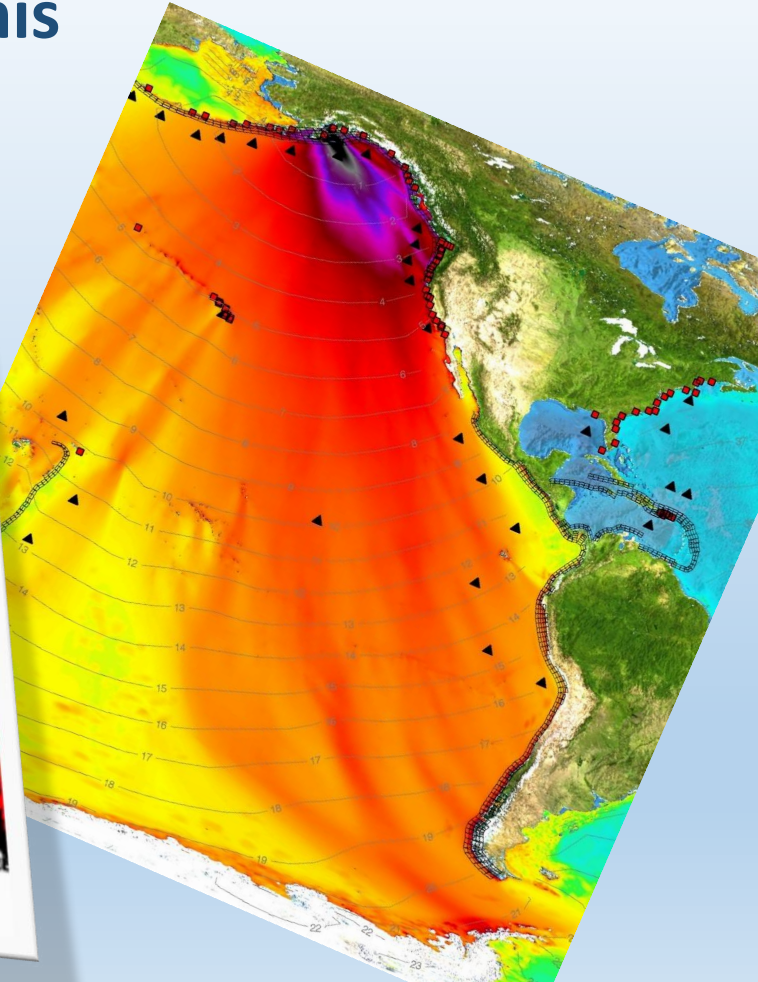
## California, 2011

- $100M in damage
- 24+ harbors
- Some closed for up to a year, some have yet to recover

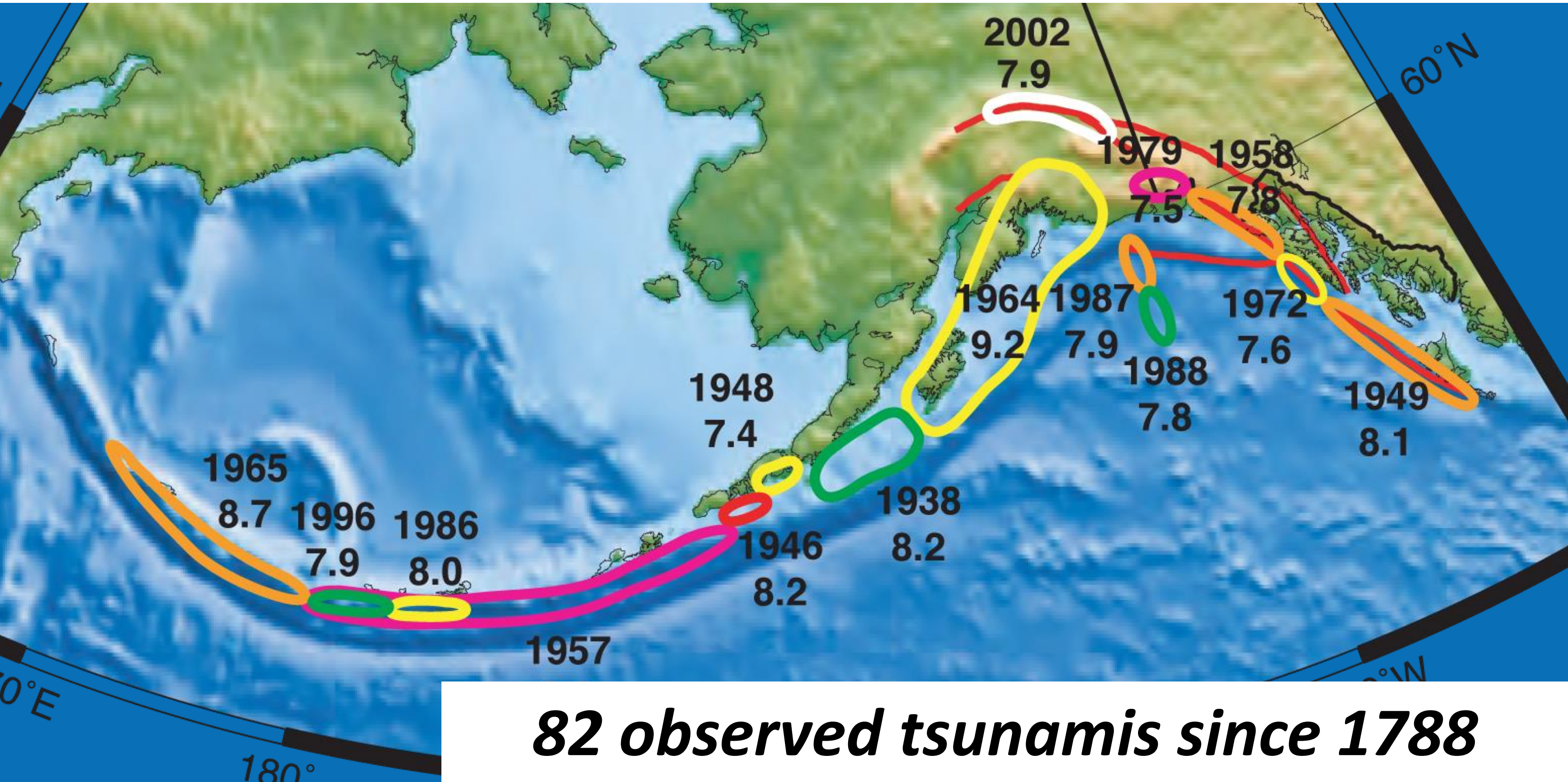
# Distant Tsunamis

Arrival time > 3 hours



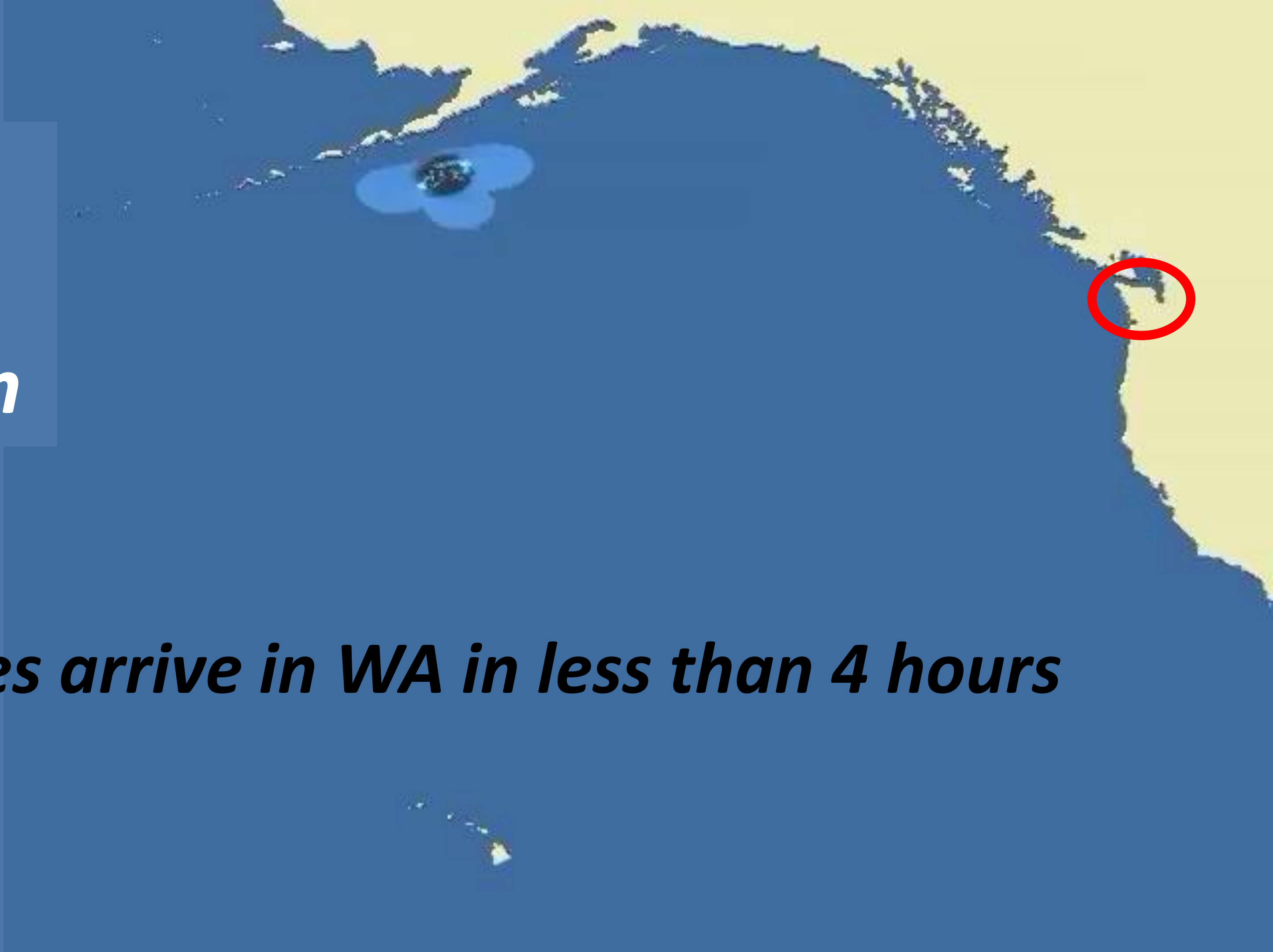


# *Large Alaskan earthquakes from 1900 to 2004*



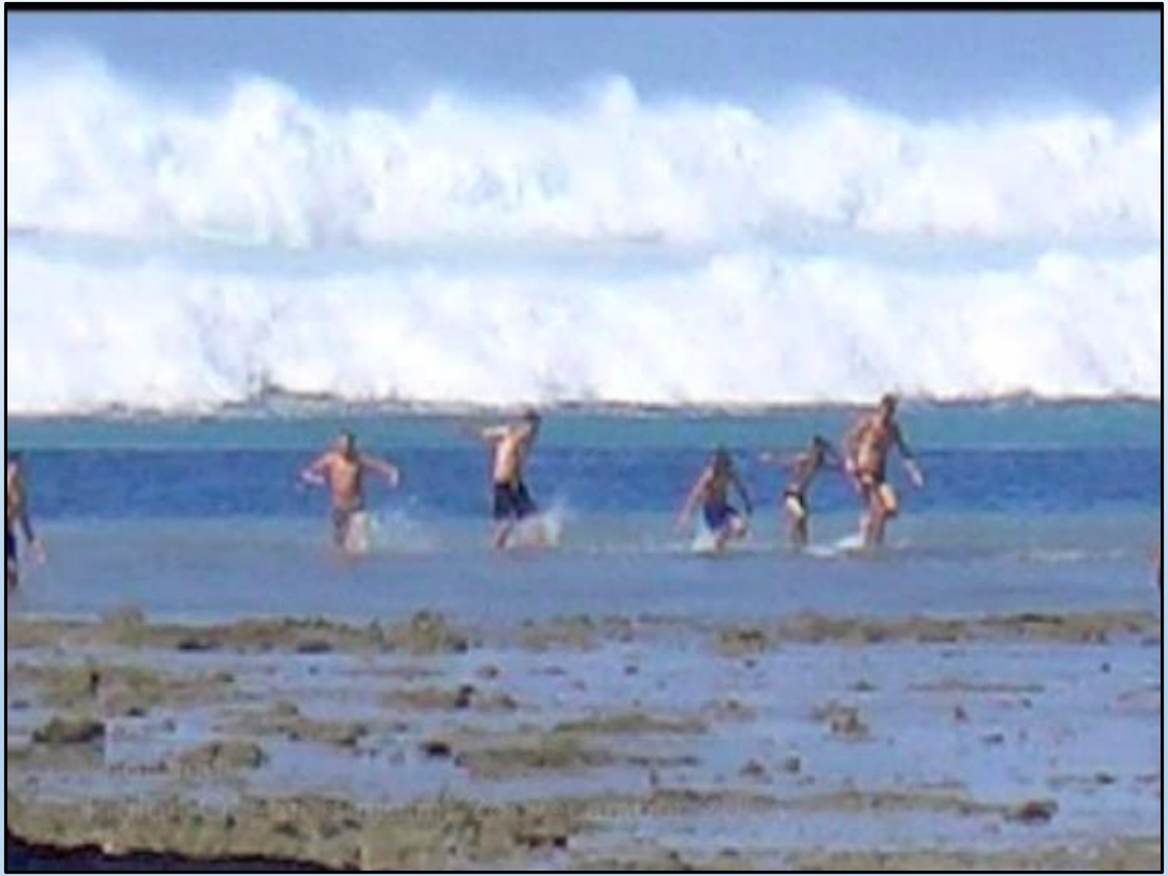
***82 observed tsunamis since 1788***

# *Alaska tsunami simulation*



***Waves arrive in WA in less than 4 hours***

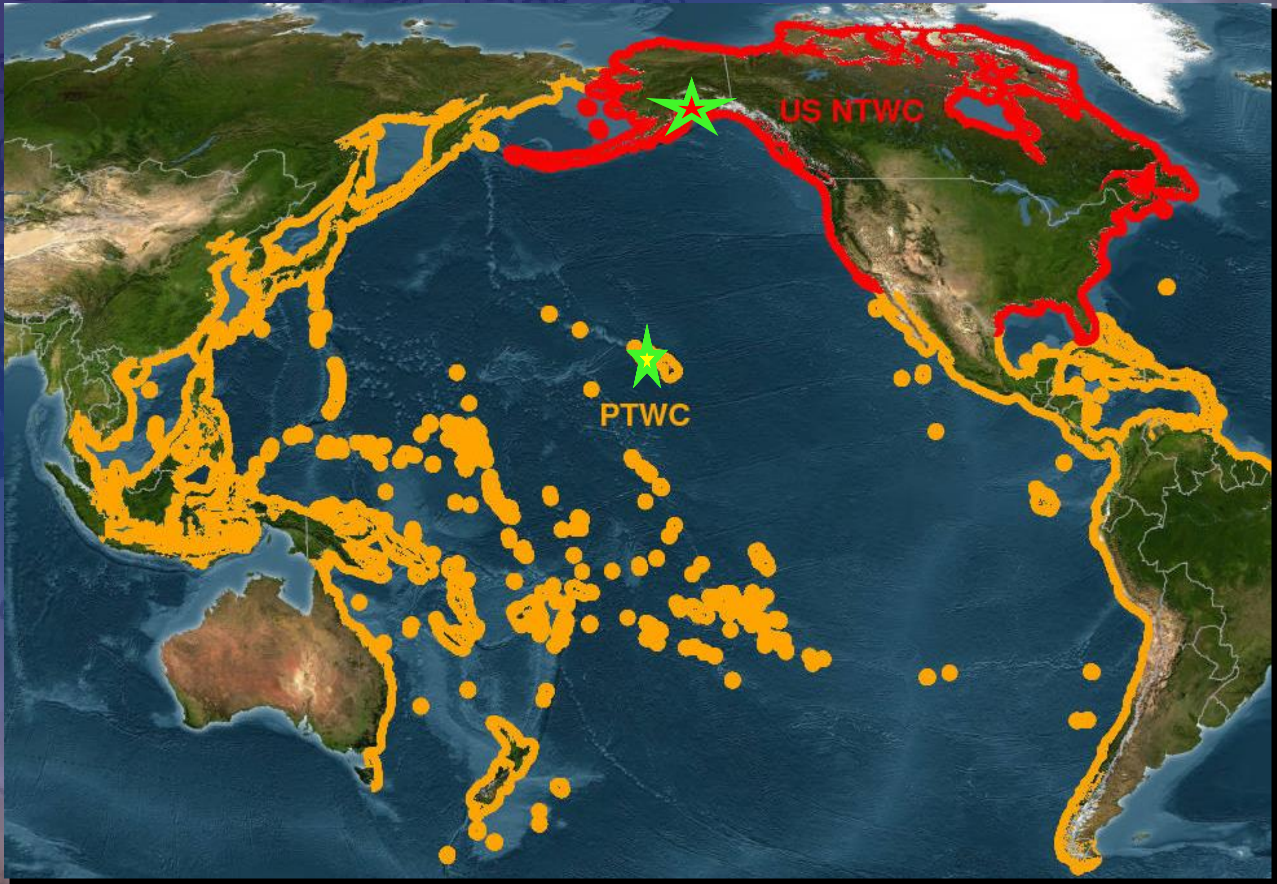
# Waves only a couple feet high…



# NWS: 2x Tsunami Warning Centers

**Pacific Tsunami Warning Center**
(Honolulu, HI)

International warning center for 26 member countries and Hawaii



**National Tsunami Warning Center**
(Palmer, AK)

Issues all tsunami products for AK, BC, WA, OR, CA –all of North America

# Process for Issuing a Tsunami Warning

- Earthquake occurs
- Automated seismic sensors alert TWC's
- Earthquake is initially located and sized automatically
- Information compared to historical database
- Tsunami Warning/alert messages disseminated
- Monitor tide gauges and DART buoys to confirm tsunami
- If no wave is recorded on tide gages, warning is cancelled.

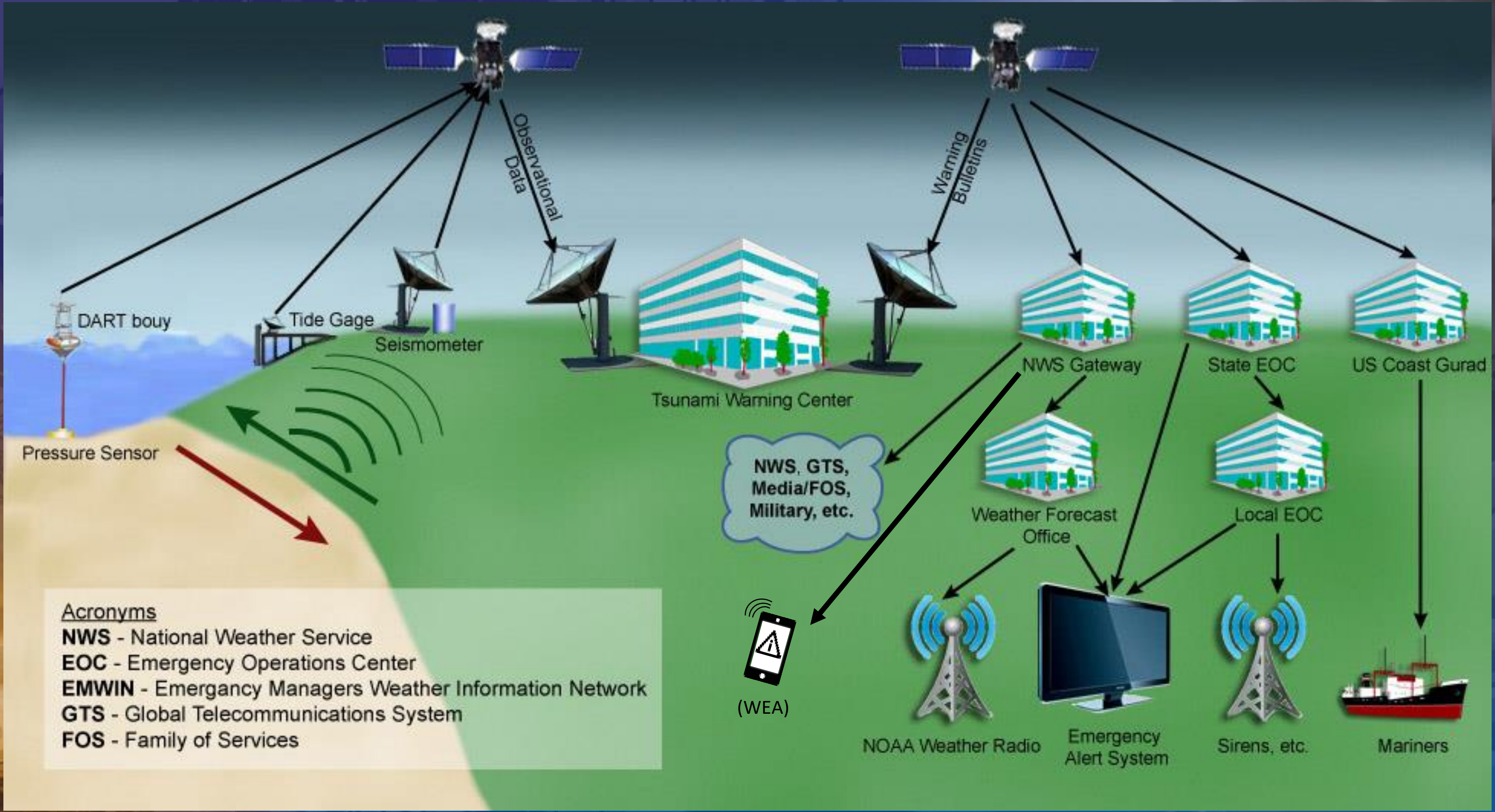
# Tsunami Alerts

| Alert Name | Actions | Potential Hazards |
|---|---|---|
| ⚠ **WARNING** | Get to high ground or inland IMMEDIATELY<br>Follow tsunami evacuation signage | DANGER! TSUNAMI IMMINENT!<br>Flooding/powerful currents<br>Wave heights > 3 ft. or unknown |
| ⚠ **ADVISORY** | Stay out of the water and away from the shore | STRONG CURRENTS AND DANGEROUS WAVES in or very near coastal water<br>Wave heights of 1 - 3 ft. |
| ⚠ **WATCH** | Be prepared to take action<br>Stay tuned to local radio/TV/ NOAA “alert” weather radios | TSUNAMI IS POSSIBLE<br>Alert level *will* change once more information is known |
| ℹ **INFORMATION STATEMENT** | No action needed | NO TSUNAMI IMPACT EXPECTED<br>Alert level may change once more information is known |

**THREAT Message: Intended to alert international partners only. Not applicable to U.S. coasts**

**THE NATIONAL TSUNAMI WARNING CENTER ISSUES OFFICIAL TSUNAMI ALERTS FOR WASHINGTON.**
**CHECK TSUNAMI.GOV OR WEATHER.GOV WEBSITES FOR TSUNAMI ALERT DETAILS.**

# Process for Issuing a Tsunami Alert/Warning

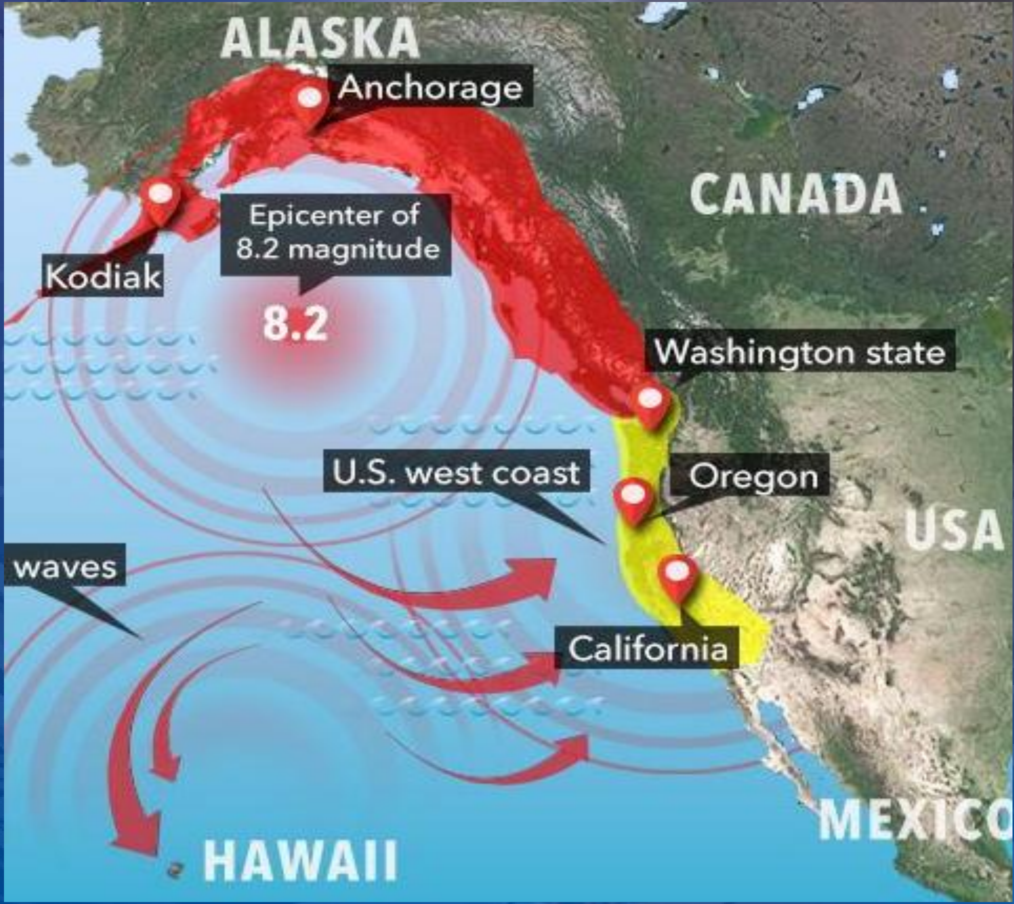


Acronyms

**NWS** - National Weather Service
**EOC** - Emergency Operations Center
**EMWIN** - Emergancy Managers Weather Information Network
**GTS** - Global Telecommunications System
**FOS** - Family of Services

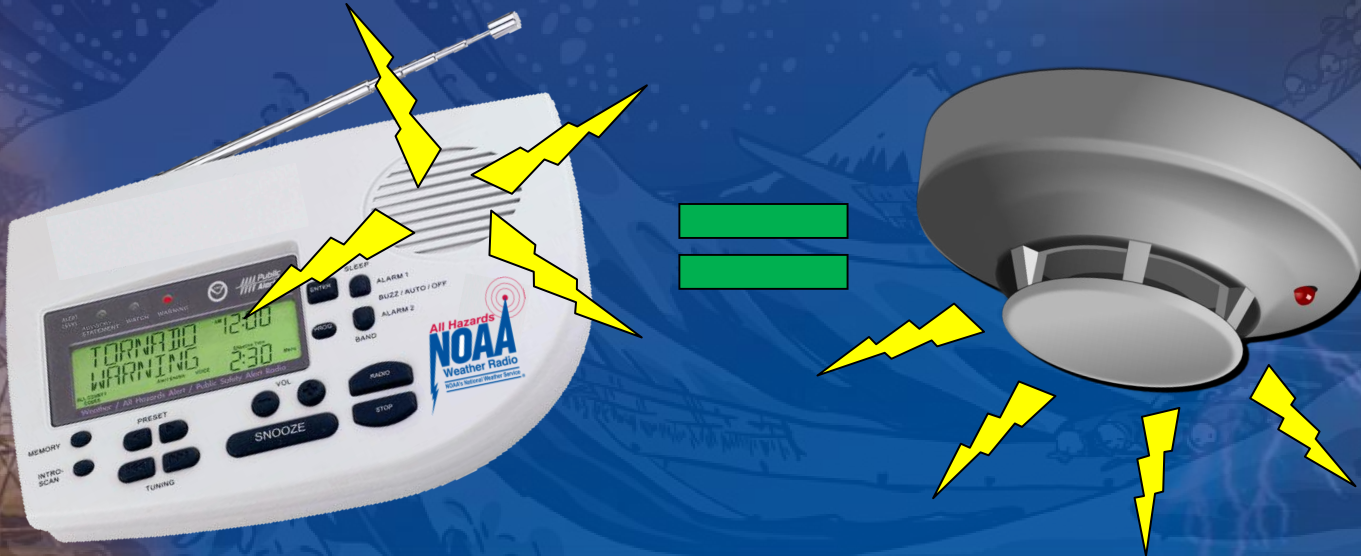
# Tsunami Alert Dissemination

- Tsunami alerts occur for any type of tsunami event
- They are MOST important during a DISTANT source event
- How do you receive alerts?
- How to do you stay informed?



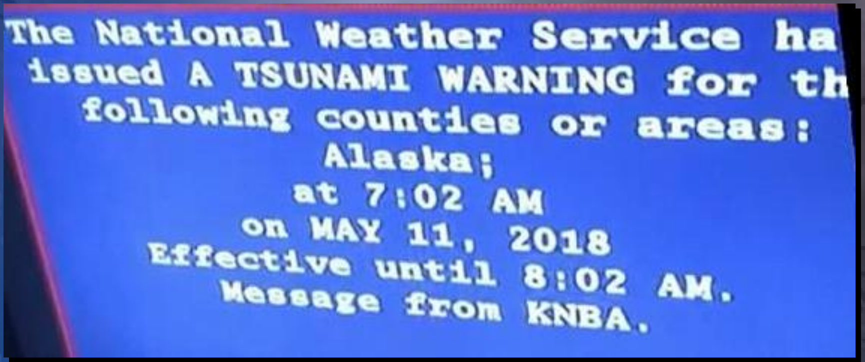
# NOAA Weather Radio

- Warning Alarm Feature just like a fire alarm
- They are NOT just for Tsunami alerts (e.g. Tornados, storms, wind)
- 16 Stations in Washington, you must program the radio to your area
- New models are programed to only sounds an alarm for a WARNING

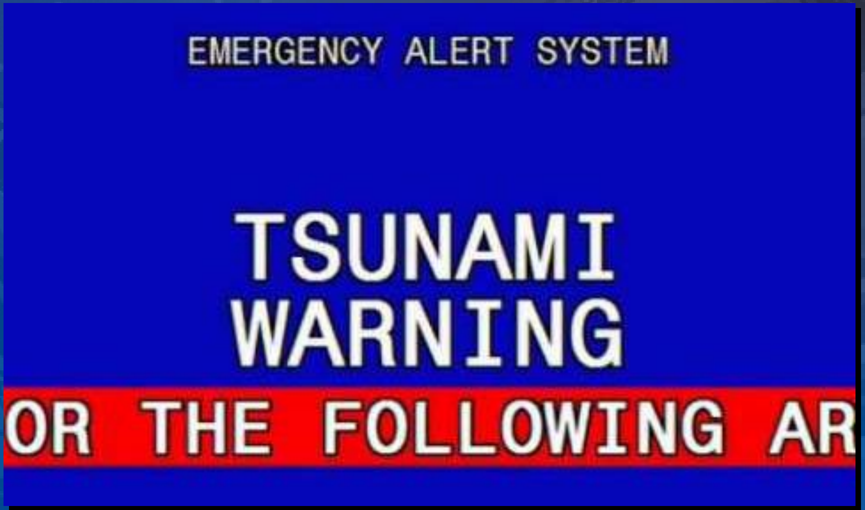


# Emergency Alert System (EAS)

- Originally designed for the President to address the nation in times of a disaster
  - *Life-threatening Weather*
  - *Natural Hazards*
  - *Also used by law enforcement (Amber Alerts)*
- If you hear the steady EAS tone or see the crawler message for Watch or a warning, you should take action.



The National Weather Service ha
issued A TSUNAMI WARNING for th
following counties or areas:
Alaska;
at 7:02 AM
on MAY 11, 2018
Effective until 8:02 AM.
Message from KNBA.



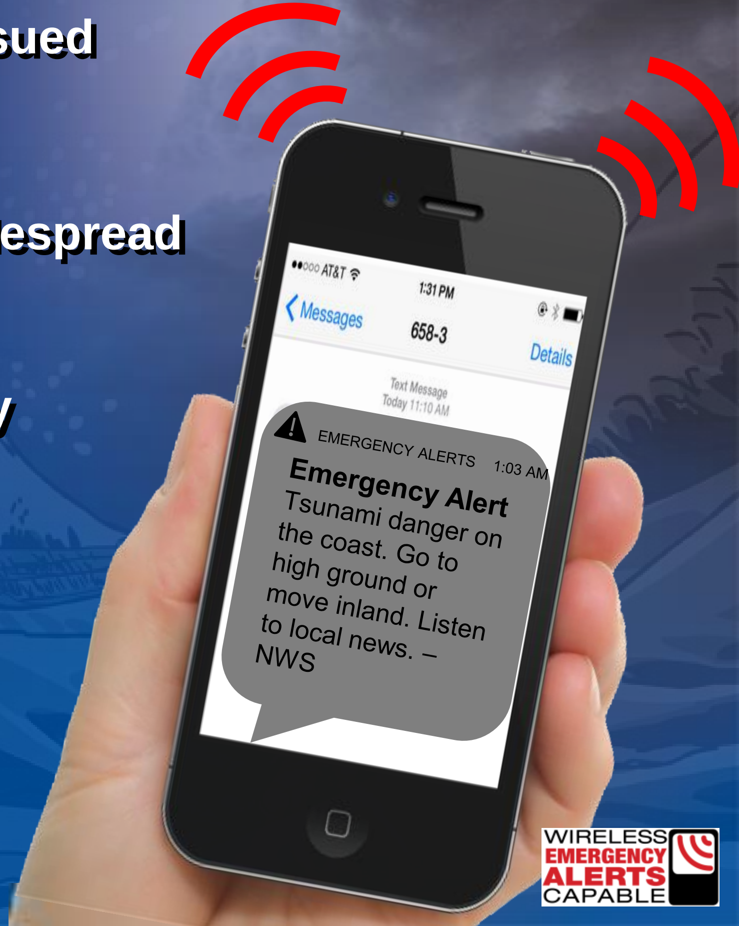
EMERGENCY ALERT SYSTEM

TSUNAMI
WARNING

OR THE FOLLOWING AR

# Wireless Emergency Alerts (WEA)

- Used ONLY when a tsunami Warning alert is issued
- You will only receive ONE message, once!
- Participation in WEA by wireless carriers is widespread but only voluntary
- Even if you have WEA-enabled device, you may not a receive WEA:
  - If your device is roaming
  - In a service area where the provider is not offering WEA

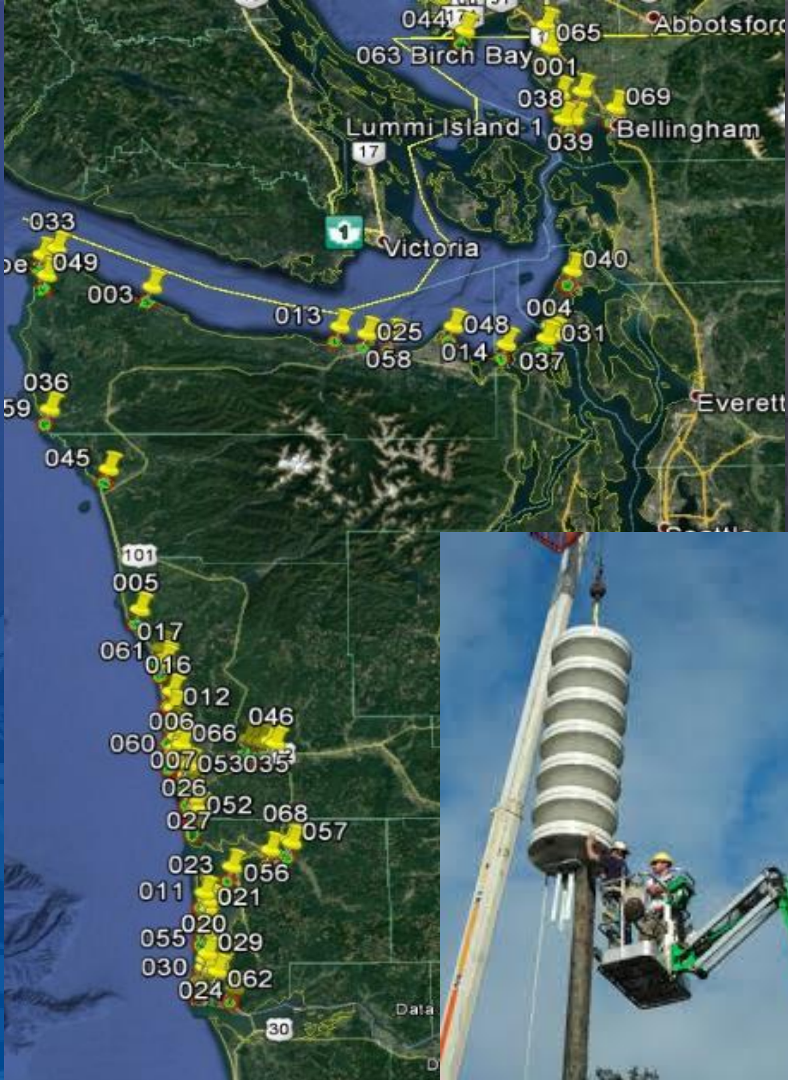


Emergency Alert
Tsunami danger on the coast. Go to high ground or move inland. Listen to local news. – NWS

WIRELESS
EMERGENCY
ALERTS
CAPABLE

# All Hazard Alert Broadcast Sirens

- OUTDOOR Tsunami Warning System
- 72 sirens
- The state Alert and Warning Center activates sirens upon receipt of an official Tsunami WARNING from the NTWC
  - Locals can activate at any time
- Wailing Tone followed by verbal warning in English and Spanish



# Stay Informed

Sign up for notifications from NTWC

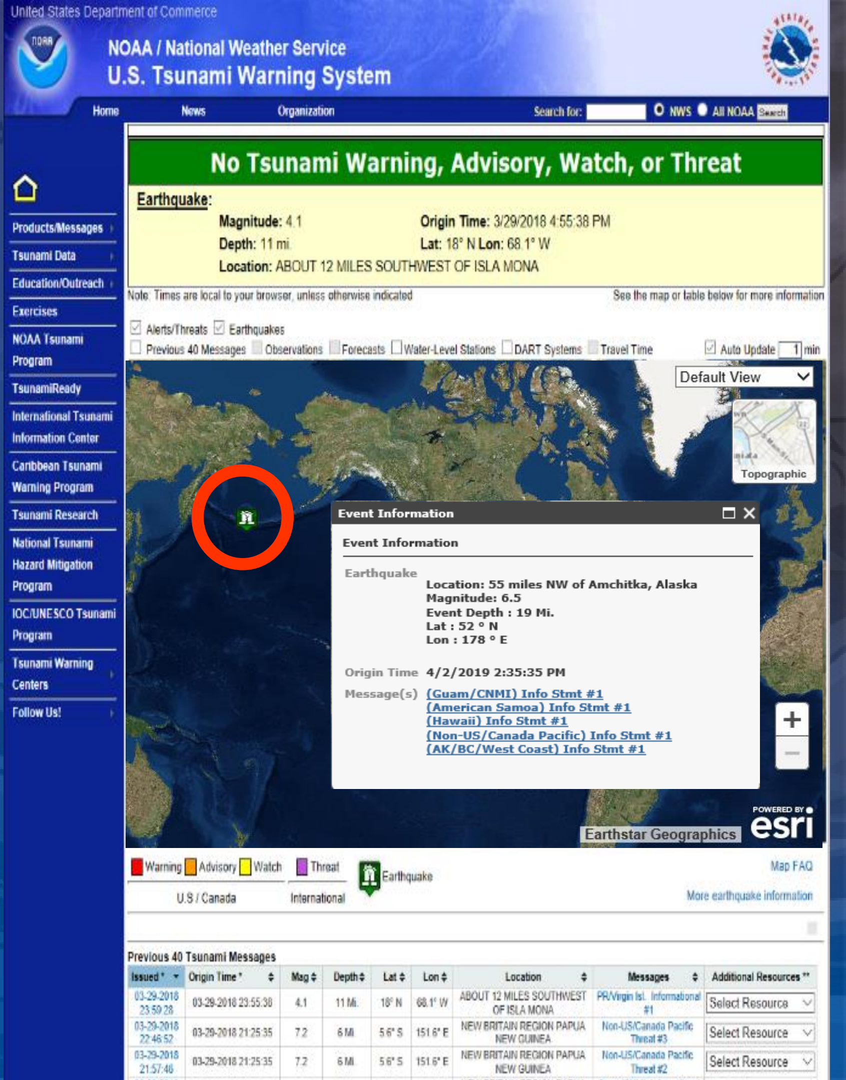
- SMS via NTWC Twitter feed (not just for WA)
  - *Send text message to 40404 with "Follow NWS_NTWC" as  the message*

- Email service via UNESCO/IOC email service
  - *tsunami-information-ioc@lists.unesco.org*

- Social media
  - *NWS_NTWC*
  - *https://www.facebook.com/NWSNTWC*

# Tsunami.gov

- Visually displays where earthquakes occur and Alert levels
- Look for messages for: AK/BC/US West Coast
- Lists last 40 messages issued at the bottom
  - *Newest messages are at the top*
  - *Database of all messages*
- Links to all sorts of additional information
- Has a history of crashing during big events



**No Tsunami Warning, Advisory, Watch, or Threat**

**Earthquake:**

**Magnitude:** 4.1 **Origin Time:** 3/29/2018 4:55:38 PM
**Depth:** 11 mi. **Lat:** 18° N **Lon:** 68.1° W
**Location:** ABOUT 12 MILES SOUTHWEST OF ISLA MONA

Note: Times are local to your browser, unless otherwise indicated

See the map or table below for more information

☑ Alerts/Threats ☑ Earthquakes
☐ Previous 40 Messages ☐ Observations ☐ Forecasts ☐ Water-Level Stations ☐ DART Systems ☐ Travel Time ☑ Auto Update 1 min

**Event Information**

**Event Information**

Earthquake
**Location: 55 miles NW of Amchitka, Alaska**
**Magnitude: 6.5**
**Event Depth : 19 Mi.**
**Lat : 52 ° N**
**Lon : 178 ° E**

Origin Time **4/2/2019 2:35:35 PM**

Message(s) **(Guam/CNMI) Info Stmt #1**
**(American Samoa) Info Stmt #1**
**(Hawaii) Info Stmt #1**
**(Non-US/Canada Pacific) Info Stmt #1**
**(AK/BC/West Coast) Info Stmt #1**

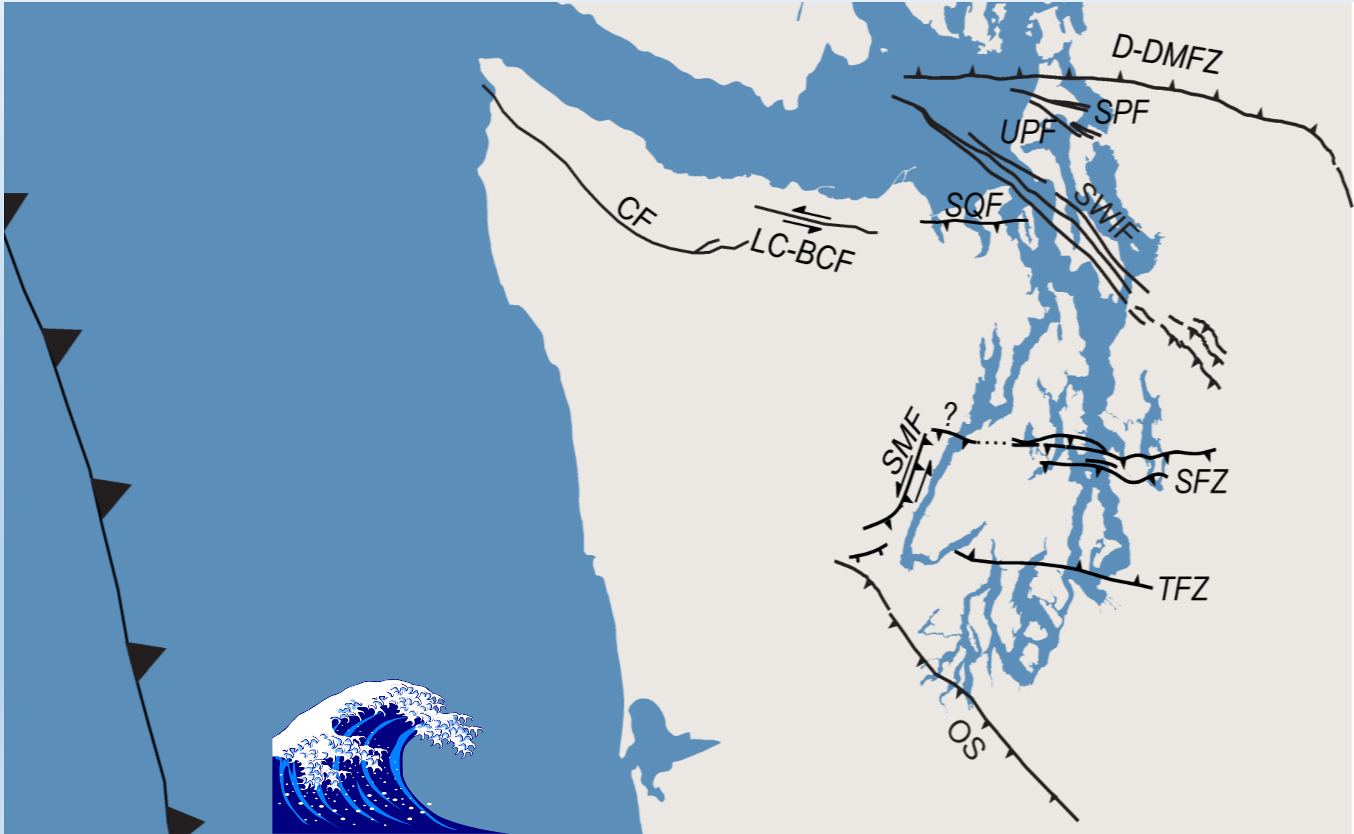
Previous 40 Tsunami Messages

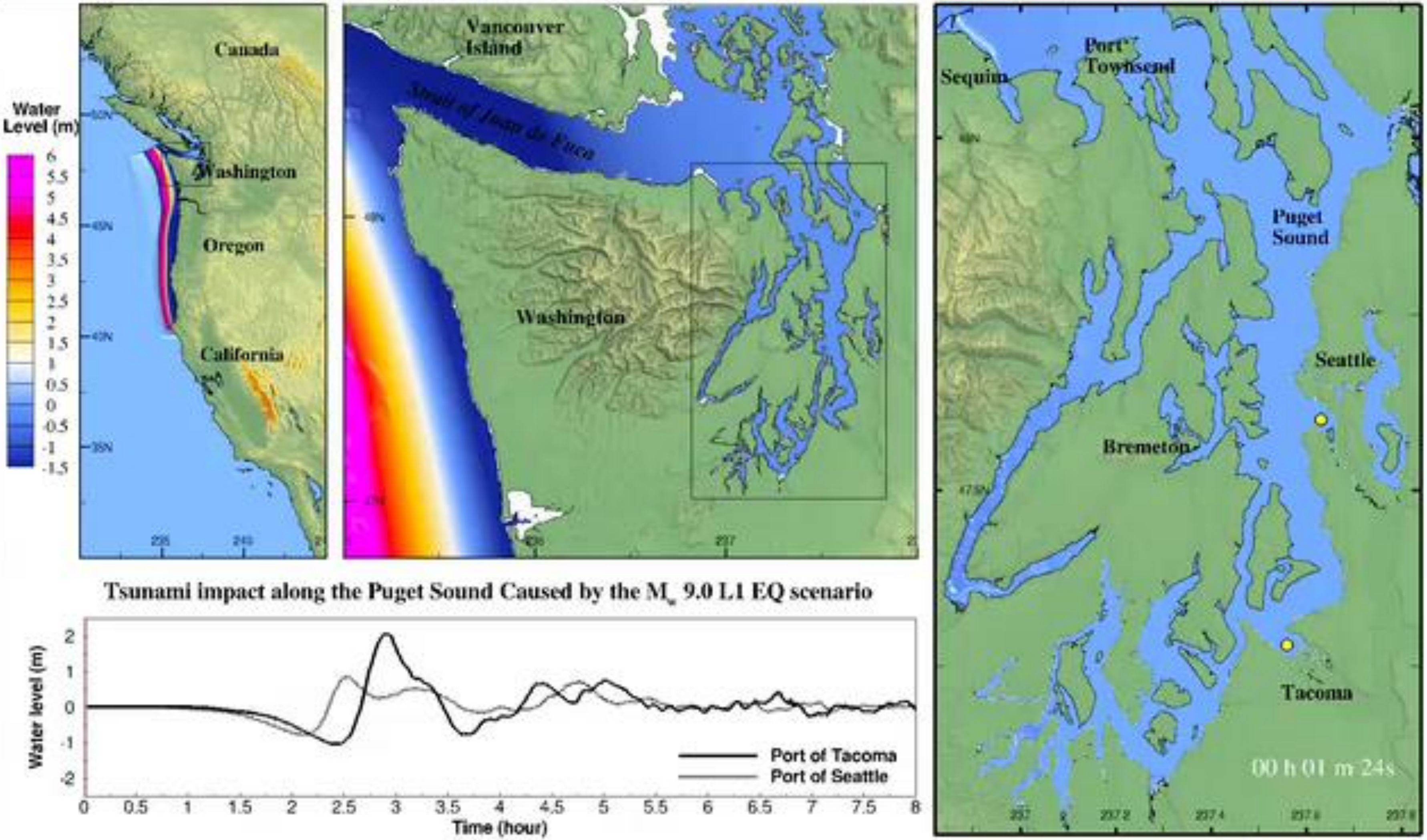
| Issued * | Origin Time * | Mag | Depth | Lat | Lon | Location | Messages | Additional Resources ** |
|---|---|---|---|---|---|---|---|---|
| 03-29-2018 23:59:28 | 03-29-2018 23:55:38 | 4.1 | 11 Mi. | 18° N | 68.1° W | ABOUT 12 MILES SOUTHWEST OF ISLA MONA | PR/Virgin Isl. Informational #1 | Select Resource |
| 03-29-2018 22:46:52 | 03-29-2018 21:25:35 | 7.2 | 6 Mi. | 5.6° S | 151.6° E | NEW BRITAIN REGION PAPUA NEW GUINEA | Non-US/Canada Pacific Threat #3 | Select Resource |
| 03-29-2018 21:57:46 | 03-29-2018 21:25:35 | 7.2 | 6 Mi. | 5.6° S | 151.6° E | NEW BRITAIN REGION PAPUA NEW GUINEA | Non-US/Canada Pacific Threat #2 | Select Resource |

# Local Tsunamis

The first waves within seconds to minutes

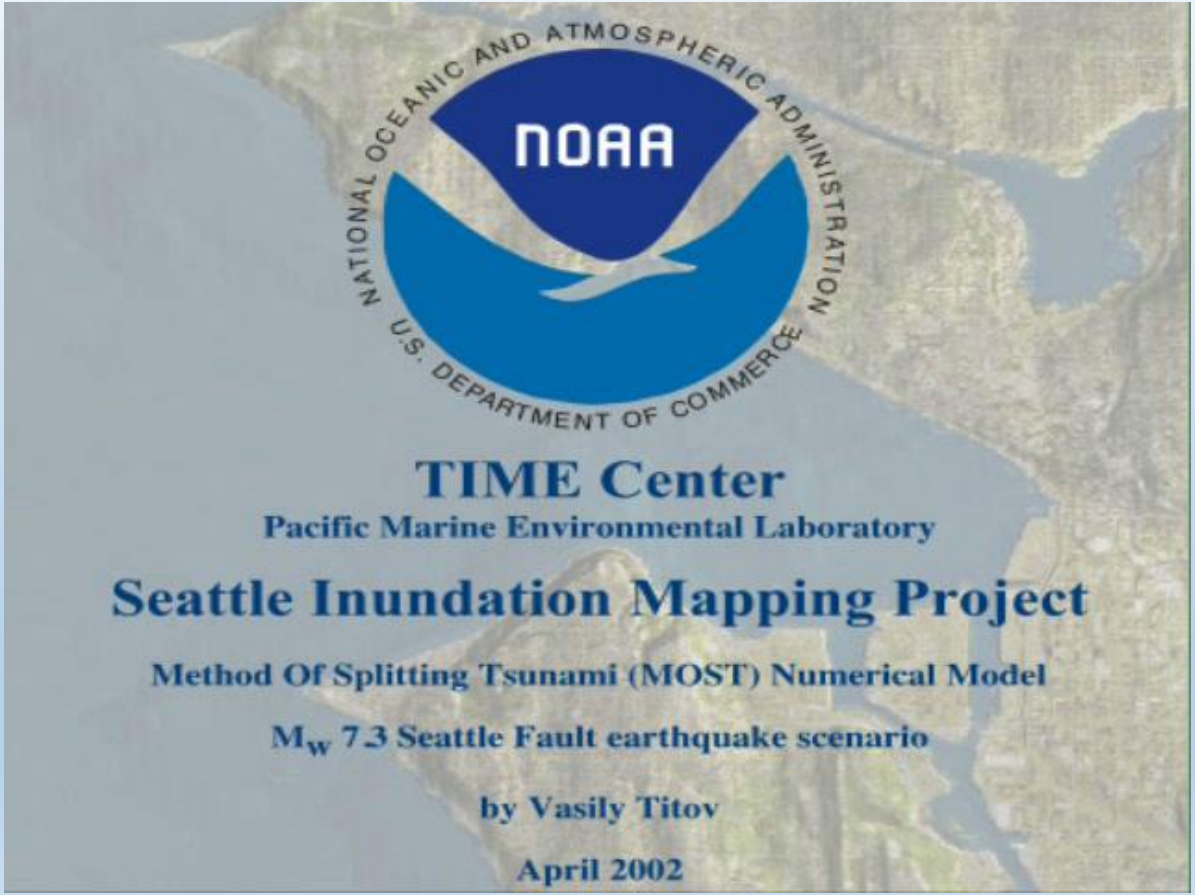
- *Cascadia Subduction Zone Fault*
- *Seattle Fault*
- *Tacoma Fault*
- *South Whidbey Island Fault*
- *Devils Mountain Fault*





Tsunami impact along the Puget Sound Caused by the $M_w$ 9.0 L1 EQ scenario

# Seattle Fault Scenario -Seattle Inundation



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NOAA

**TIME Center**

**Pacific Marine Environmental Laboratory**

**Seattle Inundation Mapping Project**

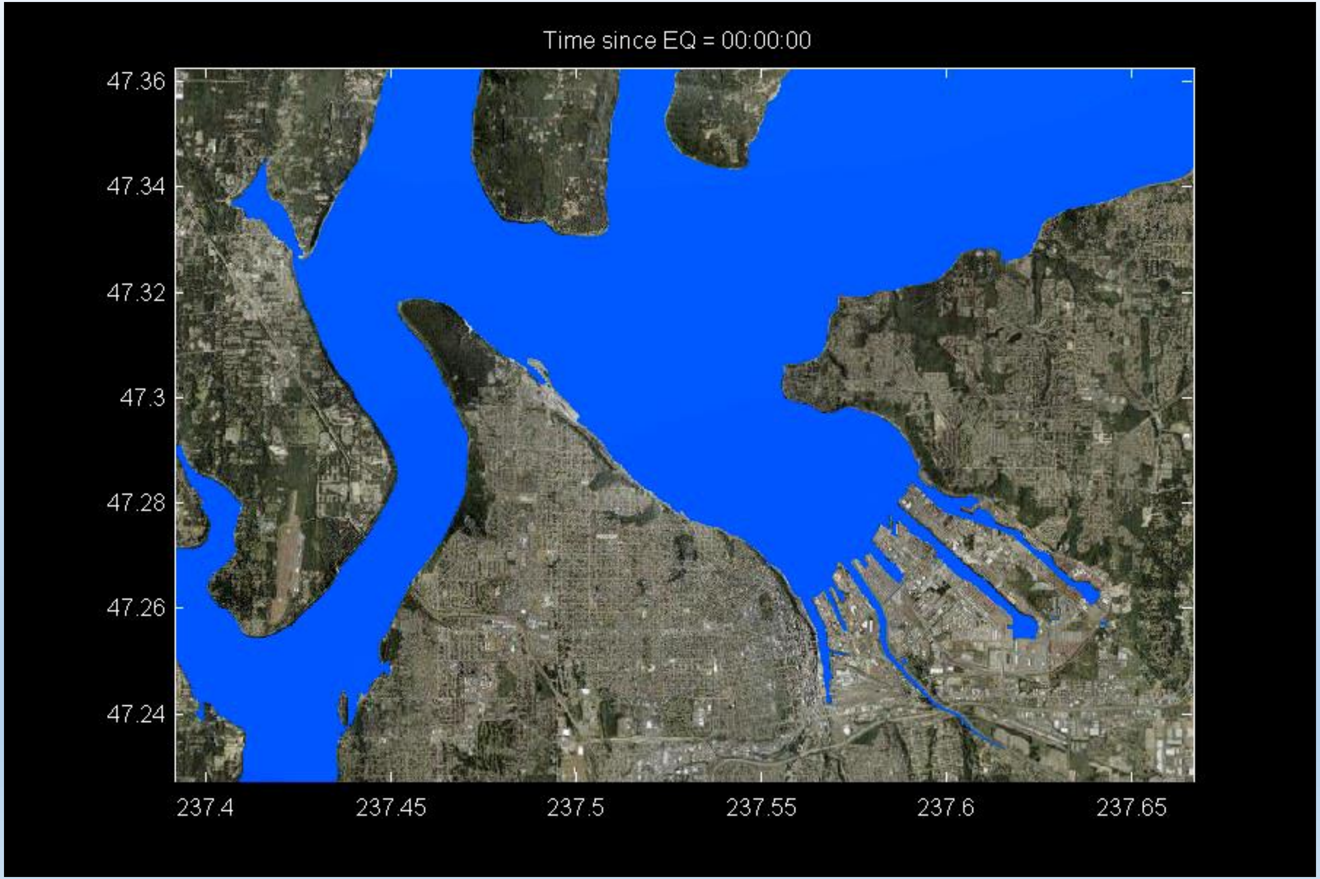
**Method Of Splitting Tsunami (MOST) Numerical Model**

**$M_W$ 7.3 Seattle Fault earthquake scenario**

**by Vasily Titov**

**April 2002**

# Seattle Fault Scenario-Tacoma Inundation



# NATURAL Tsunami Warning Signs

Feel a strong or long earthquake

See a sudden rise or fall of the ocean

Hear a loud roar from the ocean

**TSUNAMI HAZARD ZONE**

IN CASE OF EARTHQUAKE, GO TO HIGH GROUND OR INLAND

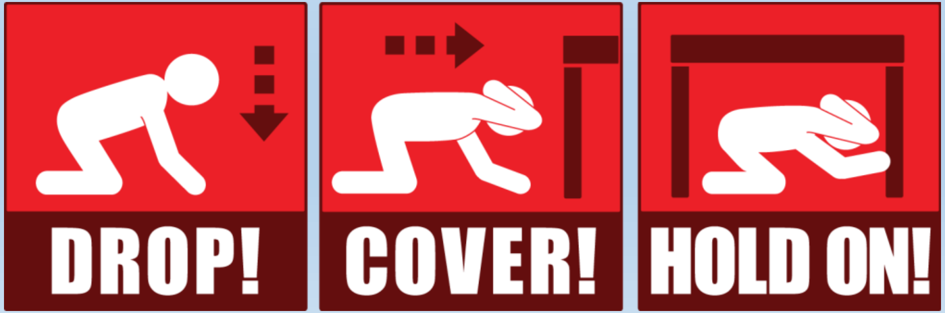
Move NOW to high ground or inland!

# Are YOU Prepared?

- How will I know a tsunami is coming (get alerted)?
- Do I know my evacuation routes (have I practiced walking them)?
- Do I have a “Family Emergency Plan”?
- Do I have a go bag ready to take with me?
- How will I communicate/reunite with my family?
- Am I involved in Neighborhood / Community Preparedness?

DON’T WAIT.
COMMUNICATE.
MAKE YOUR
EMERGENCY PLAN TODAY.

# First, Survive the Earthquake


DROP!
COVER!
HOLD ON!

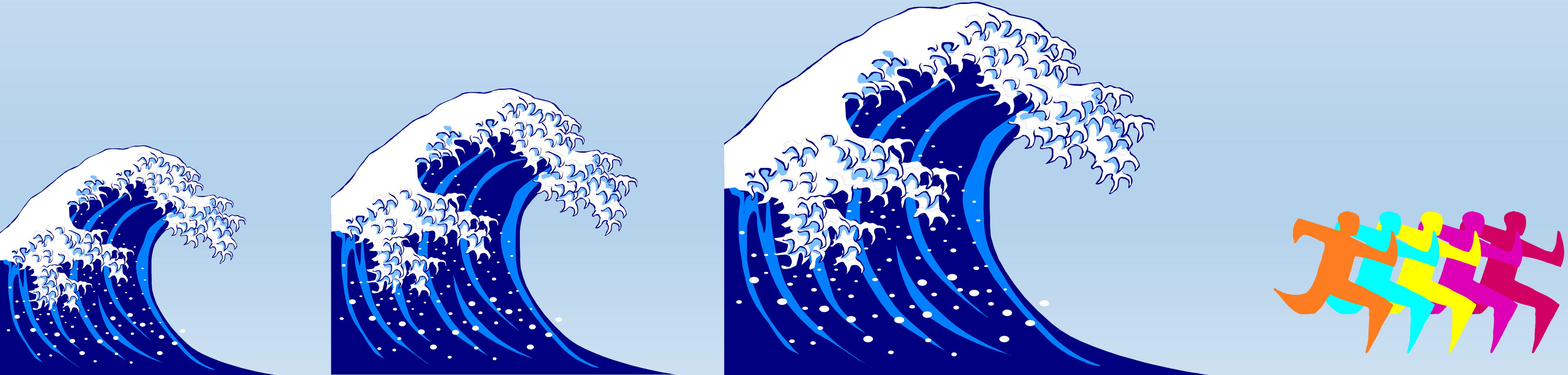
The Great Washington ShakeOut™

It could save your life! - Mexico City 1985

# Get Moving!

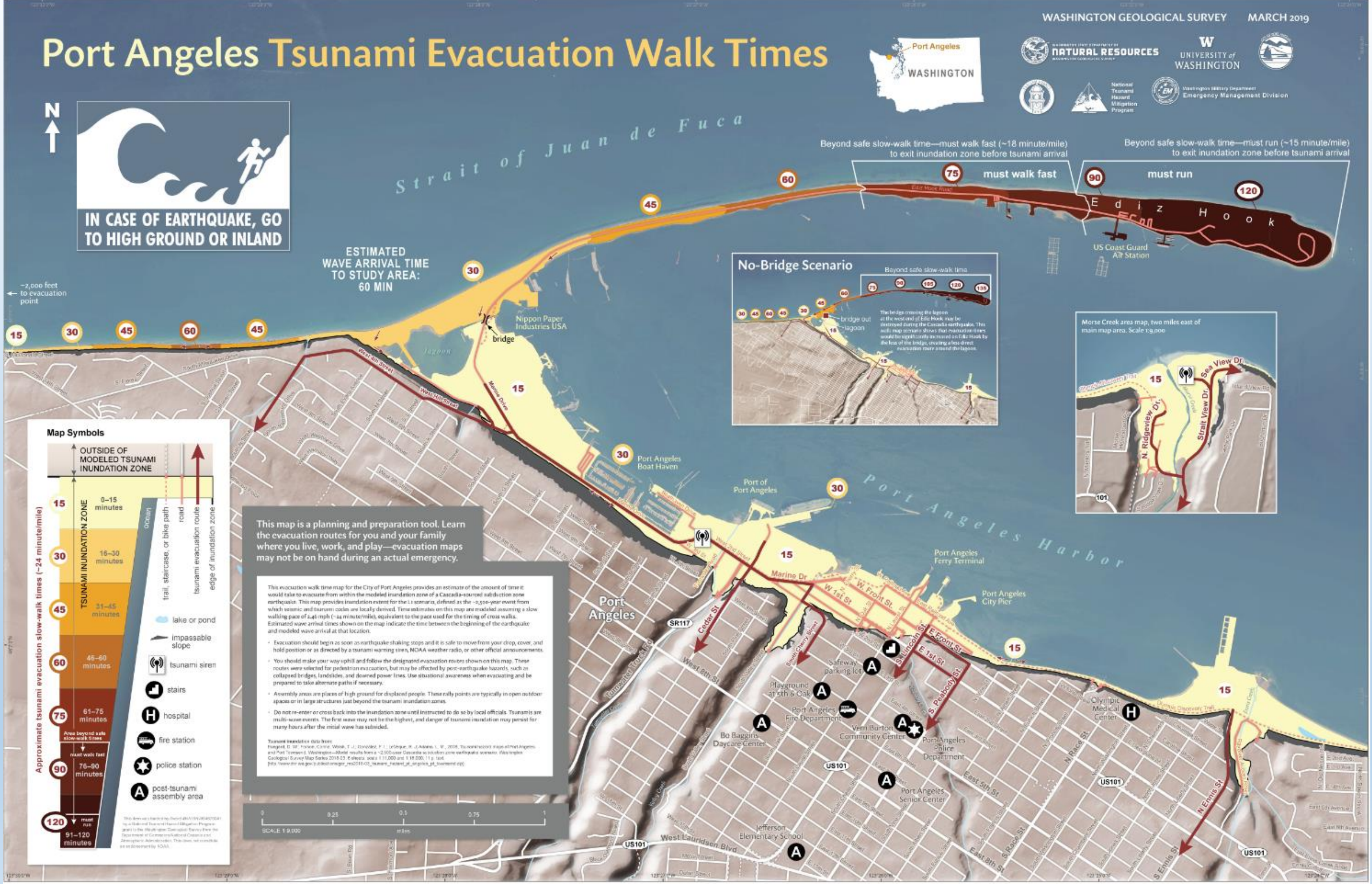
- When shaking stops get to high ground, immediately!
- Tsunamis come in a series of waves
- The first wave is often not the highest wave

Get Off and Stay Off the beach



WASHINGTON GEOLOGICAL SURVEY MARCH 2019

# Port Angeles Tsunami Evacuation Walk Times



Beyond safe slow-walk time—must walk fast (~18 minute/mile) to exit inundation zone before tsunami arrival

Beyond safe slow-walk time—must run (~15 minute/mile) to exit inundation zone before tsunami arrival

The bridge crossing the lagoon at the west end of Ediz Hook may be destroyed during the Cascadia earthquake. This walk map scenario shows that evacuation times would be significantly increased on Ediz Hook by the loss of the bridge, creating a less direct evacuation route around the lagoon.

This map is a planning and preparation tool. Learn the evacuation routes for you and your family where you live, work, and play—evacuation maps may not be on hand during an actual emergency.

This evacuation walk time map for the City of Port Angeles provides an estimate of the amount of time it would take to evacuate from within the modeled inundation zone of a Cascadia-sourced subduction zone earthquake. This map provides inundation extent for the L1 scenario, defined as the ~2,500-year event from which seismic and tsunami codes are locally derived. Time estimates on this map are modeled assuming a slow walking pace of 2.46 mph (~24 minute/mile), equivalent to the pace used for the timing of cross walks. Estimated wave arrival times shown on the map indicate the time between the beginning of the earthquake and modeled wave arrival at that location.

- Evacuation should begin as soon as earthquake shaking stops and it is safe to move from your drop, cover, and hold position or as directed by a tsunami warning siren, NOAA weather radio, or other official announcements.
- You should make your way uphill and follow the designated evacuation routes shown on this map. These routes were selected for pedestrian evacuation, but may be affected by post-earthquake hazards, such as collapsed bridges, landslides, and downed power lines. Use situational awareness when evacuating and be prepared to take alternate paths if necessary.
- Assembly areas are places of high ground for displaced people. These rally points are typically in open outdoor spaces or in large structures just beyond the tsunami inundation zones.
- Do not re-enter or cross back into the inundation zone until instructed to do so by local officials. Tsunamis are multi-wave events. The first wave may not be the highest, and danger of tsunami inundation may persist for many hours after the initial wave has subsided.

Tsunami inundation data from:

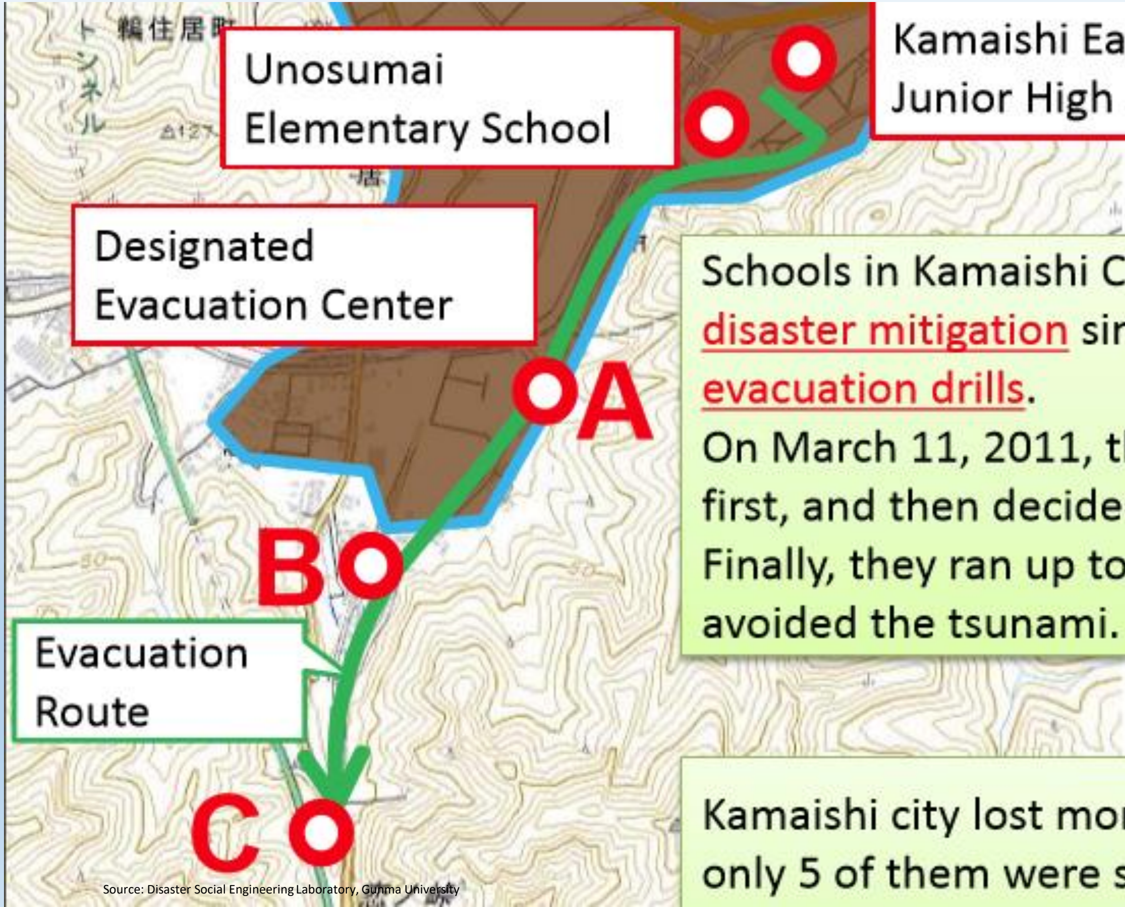
# Tragedy: Okawa Elementary School

## Tohoku 2011

- Okawa Elementary School in Japan did not conduct evacuation drills
- **72** of **76 children** were **killed** by the tsunami

https://www.japantimes.co.jp

# Success: Kamaishi City Schools


Unosumai Elementary School
Kamaishi East Junior High School
Designated Evacuation Center
A
B
Evacuation Route
C

Source: Disaster Social Engineering Laboratory, Gunma University

Schools in Kamaishi City had focused on education for disaster mitigation since 2006, and routinely conducted evacuation drills.
On March 11, 2011, the school children evacuated to “A” at first, and then decided to go further to “B”.
Finally, they ran up to “C” and all of them successfully avoided the tsunami.

Kamaishi city lost more than 1,000 lives to the disaster, but only 5 of them were school-age children.

# Join Us

in the
World’s Largest
Earthquake Drill.

**Every 3rd Thursday**
**in October**

**Great Washington**
**ShakeOut™**

**www.ShakeOut.org/Washington**

# 2 WEEKS READY

## BUILD KITS

*Plan to be on your own for at least* ***2 weeks***

- Water (1 gallon per person, per day)
- Food (non-perishable)
- Comfort/ entertainment
- Medical equipment
- Glasses/ eye care
- First aid kit
- Can opener
- Sturdy shoes
- NOAA alert radio
- Extra batteries
- Flashlight
- Warm clothes
- Personal hygiene items
- Fire extinguisher
- Tools
- Pet supplies
- Cash
- Toilet paper
- Medications
- Identification & important documents

*mil.wa.gov/preparedness*

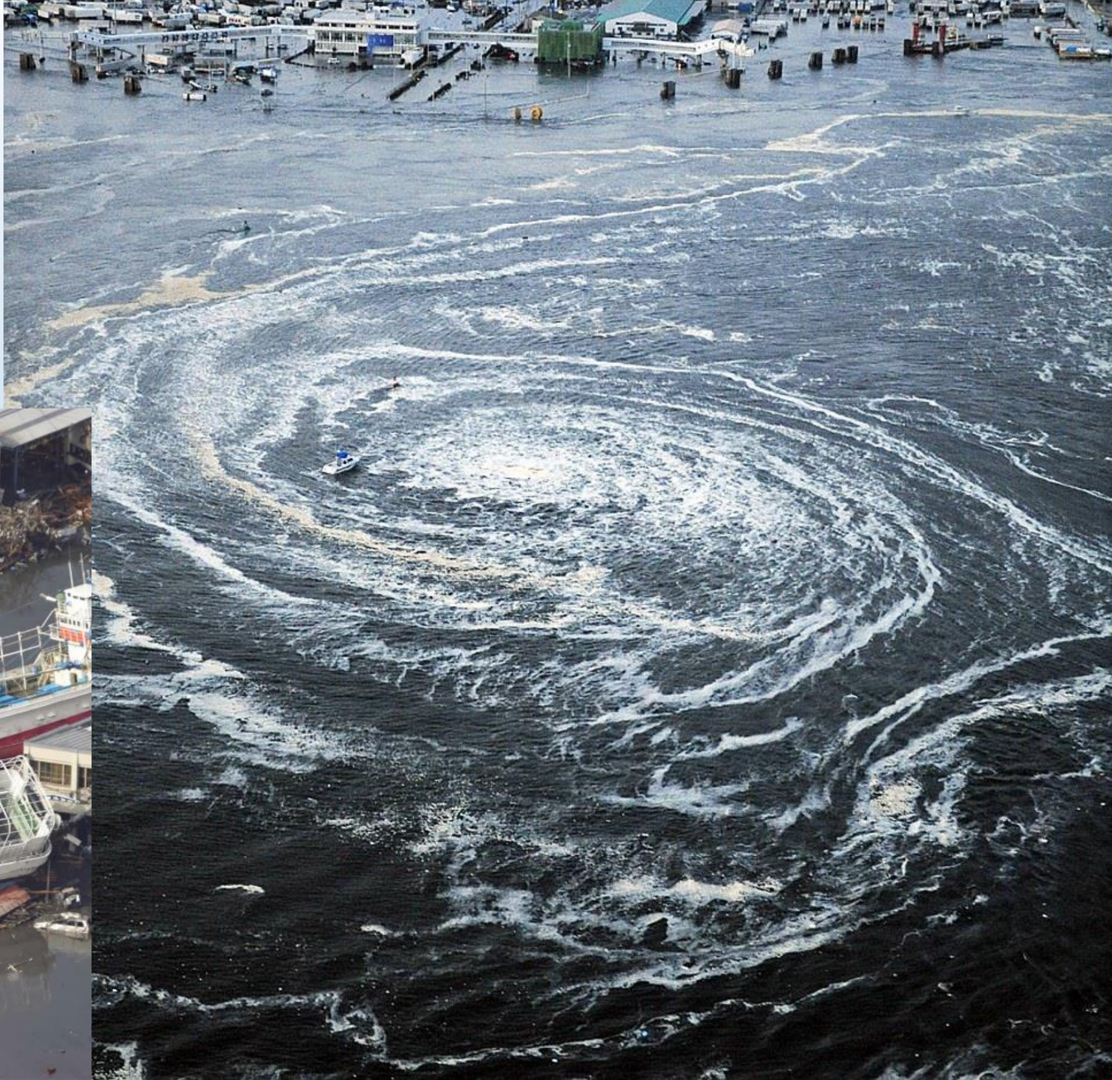
! *Keep at least 2 weeks of supplies in your home. Have smaller kits for work, for every family member, and pets. Have a vehicle safety kit too.*

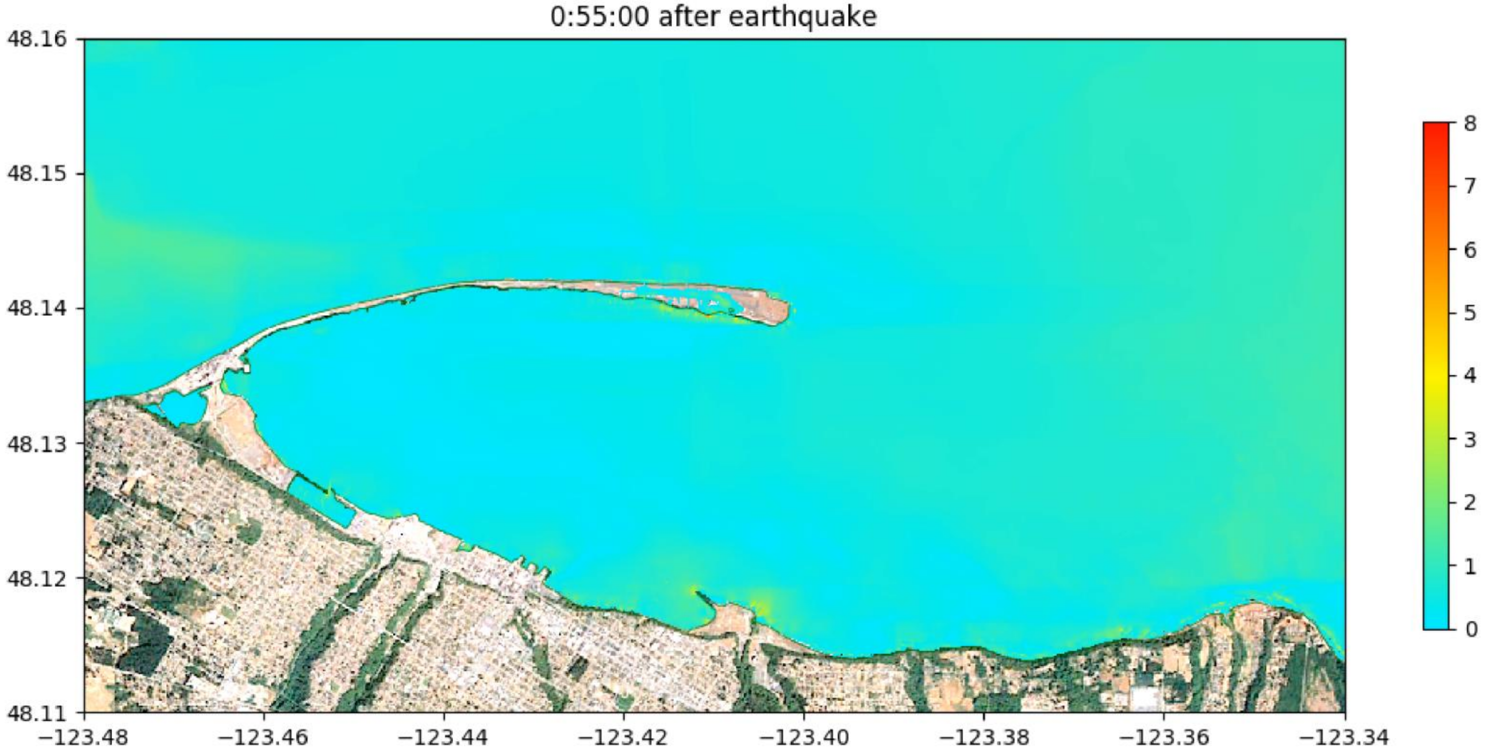
# Tsunami Evacuation Exercises

# Tsunami Hazards for Harbors and Boaters

- **Strong and unpredictable currents**, especially where there are narrow entrances, narrow openings, and other narrow parts of harbor
- Sudden **water-level fluctuations** where docks and boats:
  - Hit bottom (grounded) as water level drops
  - Could overtop piles as water level rises
  - Buoyancy of large ships, pushed on top of docks
- **Eddies/whirlpools** causing boats to lose control
- **Tsunami bores and amplified waves** resulting in swamping of boats and damage to docks
- **Drag** on large vessels causing damaging forces to the docks they are moored to
- **Debris in the water;** collision with boats, docks, and harbor buildings
- **Scour and sedimentation** can affect harbor protection measures and shipping channels
- **Dangerous tsunami conditions can last 12-24+ hours** after first wave arrival, causing problems for inexperienced and unprepared boaters who take their boats offshore
- **Contaminated water/sediment and other environmental hazards** causing delays in recovery
- **Poor decision making** by boaters and/or port/harbor personnel

# Whirlpool / Vortex




0:55:00 after earthquake
48.16
48.15
48.14
48.13
48.12
48.11
−123.48
−123.46
−123.44
−123.42
−123.40
−123.38
−123.36
−123.34
8
7
6
5
4
3
2
1
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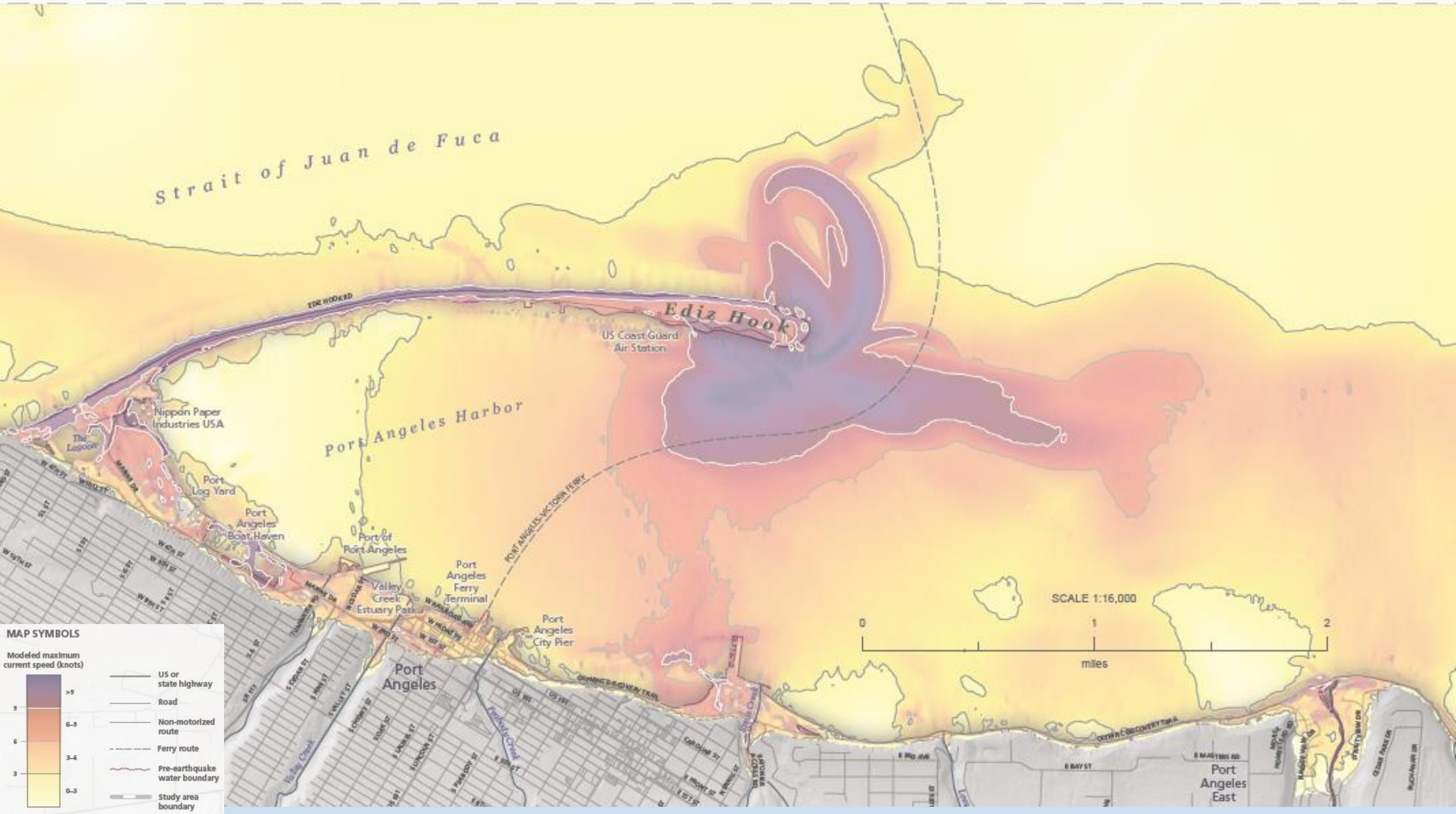
Strait of Juan de Fuca
Ediz Hook
EDIZ HOOK RD
US Coast Guard
Air Station
Nippon Paper
Industries USA
The Lagoon
Port Angeles Harbor
Port
Log Yard
Port
Angeles
Boat Haven
Port of
Port Angeles
Valley
Creek
Estuary Park
Port
Angeles
Ferry
Terminal
Port
Angeles
City Pier
PORT ANGELES–VICTORIA FERRY
Port
Angeles
Port
Angeles
East
Valley Creek
Peabody Creek
Ennis Creek
OLYMPIC DISCOVERY TRAIL
SCALE 1:16,000
0
1
2
miles
MAP SYMBOLS
Modeled maximum
current speed (knots)
>9
9
6–9
6
3–6
3
0–3
US or
state highway
Road
Non-motorized
route
Ferry route
Pre-earthquake
water boundary
Study area
boundary

# Safe Minimum Offshore Depth for Vessel Movement

Tohoku 2011 tsunami (20-30 min)

- Very risky to take ships offshore out of harbors – no time
- Evacuation to high ground was the safest decision

| State/Territory | Distant Source (ships in harbor)* | Local Source (ships at sea)* |
|---|---|---|
| **Oregon** | **30 fathoms** | **100 fathoms** |
| **Washington** | **30 fathoms** | **100 fathoms** |

*** Ships also recommended to be a minimum of ½ mile from shore**

Plan to be on your own for a while

# Go Bag

- Water Purification Kit/Tablets
- Water Bottle
- First Aid Kit
- Food
- Can Opener/Multi-tool
- HAM / NOAA Radio
- Flashlight/headlamp
- Batteries
- Firestarter

- Extra Glasses
- Essential Medications and Medical Equipment
- Warm Clothes / Poncho / Hat
- Emergency Blanket
- Essentials for Infants, Elderly, or Pets
- Important documents
- Comfort Items
- Personal hygiene

# Think of your feet

- After a nighttime earthquake the number one injury at emergency rooms is cut feet
- Keep the following in a bag tied to your bed:
  - Slip on shoes
  - Flashlight
  - Extra pair of glasses

# Get Connected

- Local Emergency Management
  - Local alerts
- Community Preparedness Groups
- Neighbors

CERT

COMMUNITY EMERGENCY
RESPONSE TEAM

MYN

Map Your Neighborhood

# Are we next? Take ACTION today!

# You CAN survive IF you get prepared!

## Questions?

## Resources

Washington State Emergency Management Division

**mil.wa.gov/preparedness**

**mil.wa.gov/tsunami**

Washington State Department of Natural Resources

**geologyportal.dnr.wa.gov**

National Oceanic and Atmospheric Administration

**www.tsunami.gov**

**For SMS: Send text message to 40404 with “Follow NWS_NTWC” as the message**

United States Geological Survey

**earthquake.usgs.gov/ens/register**